Characterize and Quantify Residual Steelhead in the Clearwater River, Idaho

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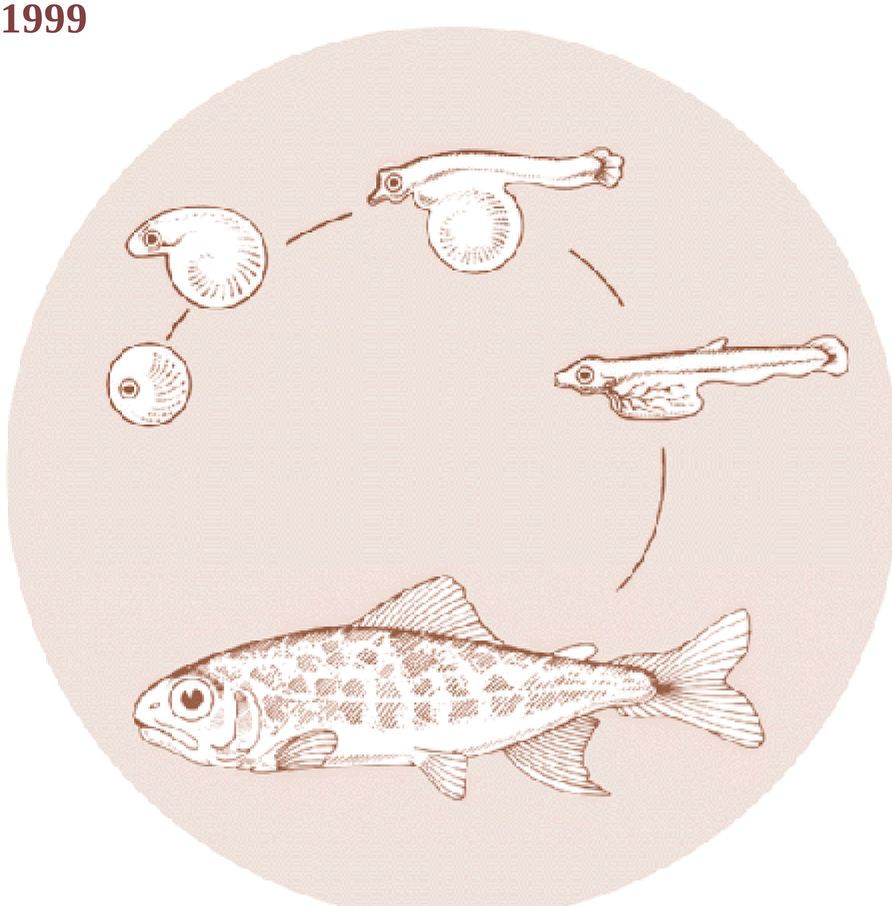
1999



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CHARACTERIZE AND QUANTIFY RESIDUAL STEELHEAD IN THE CLEARWATER RIVER, IDAHO

ANNUAL REPORT 1999

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ACKNOWLEDGMENTS

We would like to thank the Idaho Department of Fish and Game for providing electrofishing support during the first part of the summer sampling season. We extend a special thanks to our colleagues at the U.S. Fish and Wildlife Service Idaho Fishery Resource Office and Dworshak Fisheries Complex for equipment construction and maintenance, field assistance, fish rearing and tagging activities. We would also like to thank Allyn Meuleman, Project Manager, Bonneville Power Administration, for her efforts in managing this contract.

Abstract

Although sample sizes were small during the 1999 field season, we were able to verify at least some residual steelhead survive the winter to persist in the Clearwater River. Hatchery steelhead were found in low numbers migrating up tributaries of the Clearwater River where wild A-run steelhead spawn. Data from this first year did not indicate differences in survival due to size, release site, or rearing system for steelhead reared at Dworshak National Fish Hatchery. This information needs to be compared over several (at least three) years for meaningful analysis. Final analysis will also include influences of water flow and temperature in emigration success. Based on one year of data, the majority of steelhead which do not emigrate during the first couple of weeks after release, are unlikely to emigrate at all.

Introduction

Region wide there is a growing concern hatchery steelhead (*Oncorhynchus mykiss*) may be having negative impacts to wild fish. We know a substantial portion of hatchery steelhead released into the Clearwater basin do not successfully emigrate (Bigelow 1995). Yet, little is known about characteristics of hatchery steelhead which tend to residualize. Our project goals are to maximize efficiency of hatchery operations and minimize impacts to wild fish in the basin. Specific objectives include characterizing successful smolts, unsuccessful smolts (or residuals), and comparing the differences. Sampling will be done primarily electrofishing with some snorkeling. By sampling areas of the mainstem Clearwater and its tributaries for coded-wire tagged residuals (approximately 10% of production), we will obtain information on hatchery rearing systems and techniques, and sex, maturity, and piscivory of steelhead which fail to emigrate. By injecting all unmarked steelhead with Passive Integrated Transponder (PIT) tags (Prentice et al. 1990) and utilizing mark/recapture techniques, we will attempt to estimate numbers and growth rates of residuals in the Clearwater basin below Dworshak National Fish Hatchery. Length and emigration history will be obtained from all steelhead captured and released. Expected results include information leading to the production of more effective hatchery smolts, maximizing our hatchery program and minimizing negative impacts to the threatened wild steelhead and fall chinook stocks in the basin. We also expect to determine if unsuccessful smolts are residing in the Clearwater River or simply expiring after their release to the wild.

Our objectives are to:

1. Estimate emigration success of Dworshak National Fish Hatchery steelhead smolts, evaluated by size at release, release site, and rearing system.
2. Estimate number of unsuccessful smolts residing in the Clearwater Basin throughout the summer.
3. Describe hatchery-reared steelhead which are residualizing in the basin, by size, sex, sexual maturity, and relevant hatchery practices (e.g. release site, rearing system, release size, health history).

Annual reports, summarizing emigration success, estimate of residualism rate throughout the summer, and characteristics of residualized steelhead, will be produced. A final project report will summarize these data over the three year period and include a fourth objective:

4. Determine if a relation exists between in-river conditions (flow and temperature) to emigration success, residualism rate, and persistence of residual steelhead over time.

The proposed study will test these null hypotheses:

- Dworshak NFH B-run steelhead residualism rate is not related to hatchery practices such as size at release, release site, or rearing system;
- Steelhead residualism in the Clearwater River is not related to sex or maturity; and
- Dworshak NFH B-run steelhead residualism rate is not related to mainstem Clearwater River or tributary discharge or temperature during the migration period.

Project Area

Our project area consists of the Clearwater River Basin from just upstream of Dworshak National Fish Hatchery (NFH), to the river's confluence with the Snake River in Lewiston, Idaho, roughly 66 river kilometers (rkm) (Figure 1). Also included are several tributaries. Specifically, the North Fork Clearwater River downstream of Dworshak Dam to its confluence with the mainstem (about 3 rkm) and several smaller tributaries which enter the river downstream of the hatchery: Big Canyon, Jacks, Bedrock, and Cottonwood creeks.

Methods and Materials

Sampling.—Sampling and data collection were conducted on three levels: at the hatchery prior to steelhead releases, sampling in the mainstem Clearwater River beginning just prior to hatchery releases and continuing throughout the summer (April through August), and in tributaries downstream of release sites beginning just prior to hatchery releases and continuing until stream water temperatures increased beyond safe salmonid handling conditions (April into mid-June). Emigration and growth (of subsampled fish) was monitored through the PTAGIS database.

Approximately 4,500 steelhead, stratified by size at release, release site, and rearing system, were sampled at the hatchery. Each steelhead was PIT tagged. Length was measured on all steelhead and weight was measured on subsamples from each pond. A total of 15 ponds were sampled: 5 in System I (freshwater), 6 in System II (reuse water), and 4 in System III (reuse water). Steelhead were also checked for precociousness.

Electrofishing was employed to sample steelhead on the mainstem Clearwater River. Approximately 10% of all hatchery-released steelhead receive coded-wire tags while being reared at the hatchery. Steelhead collected which were coded-wire tagged were sacrificed to determine hatchery rearing container, sex, maturity level, and stomach contents. Length data was also obtained from these fish.

Occasionally residualized steelhead will return to the hatchery via the hatchery fish ladder.

When adult fish were handled for enumeration or spawning, all residualized steelhead in the holding ponds were sampled for this project.

All steelhead captured without a coded-wire tag were measured for length and checked for precociousness and a PIT-tag. Those not already PIT tagged were tagged. All of these steelhead were released. Recaptured steelhead provided population and growth data for those fish residing in the mainstem.

Tributaries to the Clearwater River downstream of Dworshak NFH (Big Canyon, Jacks, Bedrock, and Cottonwood) were also sampled using electrofishing. Length, sex (if obvious), maturity level (if obvious), stomach contents, and marks were obtained from all hatchery fish sampled. All steelhead which were coded-wire tagged were sacrificed to obtain hatchery and pond-of-origin information, and obtain more detailed sex and maturity information. Non-coded-wire-tagged steelhead were injected with a PIT tag and released for later identification and to monitor emigration. All wild fish were enumerated and released.

Stomach analysis.—Captured steelhead were placed in a live well upon capture. Fish stomach contents were evacuated using a pressurized water container. Pressure was used to pump water into the stomachs to induce regurgitation. Regurgitated contents were collected in a 300 μm mesh strainer, preserved with 70% alcohol, and stored in whirl packs until analysis could be completed.

Stomach contents for each steelhead were analyzed primarily to determine if piscivory was occurring. However, all contents were enumerated. For each stomach, contents were placed into six categories: aquatic insects, terrestrial insects, crustaceans, fishes, molluscs, and miscellaneous food items. Insects were categorized to order. Prey items such as other fishes were categorized to the lowest easily-identifiable taxa. The number and weight of each category in each stomach was recorded. When possible, parts of insects were placed into their proper order and weighed with that group. Unidentifiable insect parts were placed and weighed in a insect parts category. Prey categories were blotted dry and weighed to the nearest mg.

Statistical analysis.—Chi-square tests were used to test emigration success and residualism rate of hatchery steelhead based on rearing system, size at release, and release site (Everitt 1977). Descriptive characteristics of residuals include sex, maturity, and piscivory.

Steelhead from the first three takes of the season were split between System I (strictly fresh water) and System II (some reused water; the warmer temperatures lead to faster growth). Three of these ponds were selected from each system to represent typical vs. faster growing steelhead. Because of unequal variance in steelhead lengths and travel times to lower Snake River dams between System I ponds, these variables were tested using a Kruskal-Wallis ANOVA (Wilkinson 1990).

Survival estimates were made for each pond using SURPH (Skalski et al. 1998). Estimates were compared by t-test or ANOVA by release site, rearing system, and typical versus faster growth.

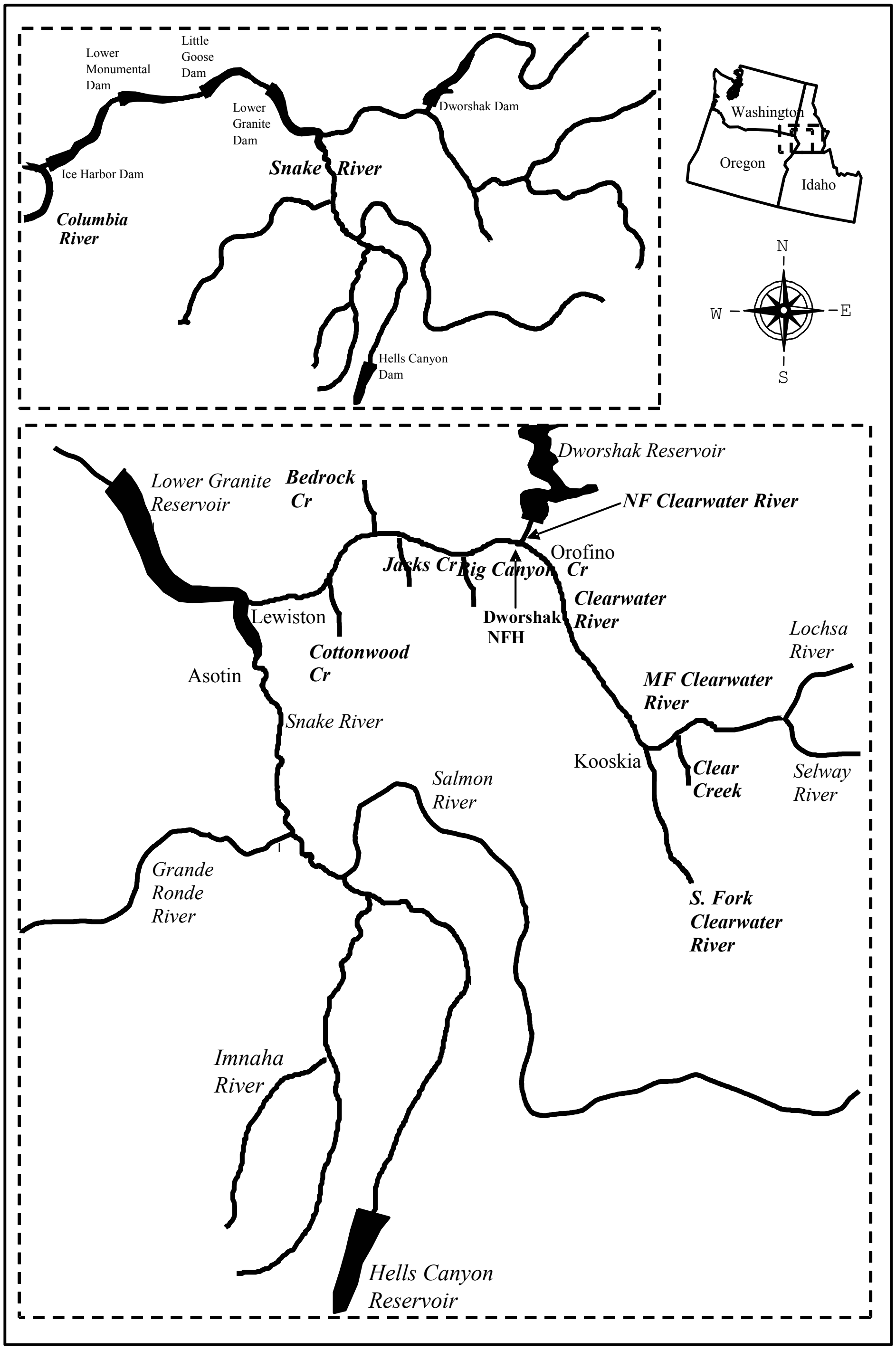

Figure 1. Map of the study area in relation to the Clearwater and Snake river drainages in Idaho.

In-river conditions, including flow and temperature in the Clearwater River, will be correlated with residual rates and emigration success based on the stratifying factors over time at the end of the study. Growth rates of wild, residual, and emigrating steelhead will also be compared at the end of the study.

Results and Discussion

Steelhead were PIT tagged at Dworshak NFH on April 8th, 14th, and 15th (Table 1). Tagging was stratified by size, release site, and hatchery rearing system.

Table 1. Steelhead PIT tagged at Dworshak National Fish Hatchery, spring 1999. Egg Take represents the week of spawning, beginning with the first week of spawning season. Steelhead in the 'faster growth' groups are from early takes and purposefully reared in the warmest system to obtain a greater mean length than general production.

		Number of steelhead PIT tagged by Rearing System		
Release Site	Egg Take	I Freshwater 1,2,3,4,5	II Reuse 1,2,3,11,12,13	III Reuse 6,7,9
Clearwater River at Dworshak NFH	1,2,3,6,7,13	903	1,202	604
Clear Creek	4,7,12	300	300	300
South Fork Clearwater River	5,9,11	300	299	300
Total	4,508	1,503	1,801	1,204

Size at release.—Steelhead lengths from typical growth ponds were significantly less than those from the faster growth ponds (P<0.01); mean fork lengths were 195.5 mm (SD=16.2) and 215.3 mm (SD=18.6; Figure 2), respectively. Despite these differences in size, no significant difference was seen in observation or survival rates of these steelhead as they moved downstream through the Columbia Basin system. Detection rate at dams on the Lower Snake and Columbia rivers combined for the faster growth group was 69.8%; for the typical growth group, detection rate was 65.7% (P=0.06). Survival estimates showed similar, non-significant, results. Survival estimates to Lower Granite dam were 77.4 % and 72.4 % for the faster growth and typical growth groups (P=0.36). To Lower Monumental Pool, survival estimates for the faster growth group averaged 67.8% and 60.2% for the typical growth group (P=0.32).

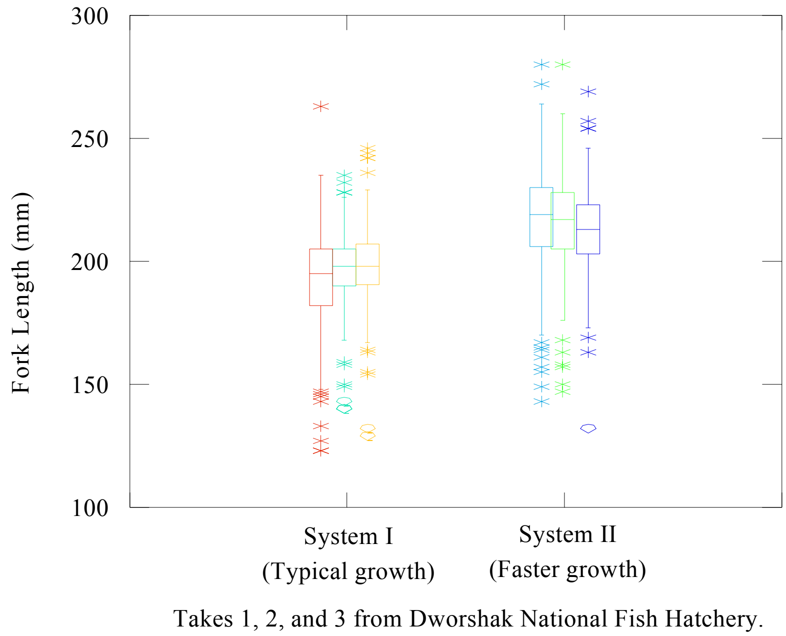

Figure 2. Mean fork length from steelhead reared in two water temperature regimes at Dworshak National Fish Hatchery, 1999. System II, with slightly warmer temperatures, produces a faster growing steelhead.

Travel times did appear to be somewhat faster for the larger fish to Lower Granite and Little Goose dams (P=0.00 and 0.01), but not to Lower Monumental Dam (P=0.36; Figure 3). Median travel times to Lower Granite, Little Goose, and Lower Monumental dams were 6.4 d, 6.7 d, and 17.1 d for the faster growth group. For the typical growth group, median travel times were 8.4 d, 10.4 d, and 16.6 d (Figure 3).

Release site.—In 1999, steelhead released into Clear Creek had a lower detection rate downstream than those released directly into the Clearwater River from Dworshak NFH or from those released in the South Fork Clearwater River. Detection rates were 65.0%, 71.1%, and 70.4% for steelhead released at Clear Creek, South Fork Clearwater, and at Dworshak NFH (P=0.01).

Mean survival estimates to Lower Granite Dam were 72.9%, 79.3%, and 81.1% for steelhead released at Clear Creek, South Fork Clearwater, and Dworshak NFH in 1999. To Lower Monumental Pool, estimates averaged 61.0%, 71.7%, and 66.3% for Clear Creek, South Fork Clearwater, and Dworshak NFH releases. Differences were not significant in either case (P=0.36 and P=0.22).

Rearing system.—Detection rate at least one observation site in the Columbia River basin was also significantly different between systems (P=0.01). System II fish were seen at a slightly higher rate (72.7%) than either System I (65.8%) or System III (67.4%) steelhead.

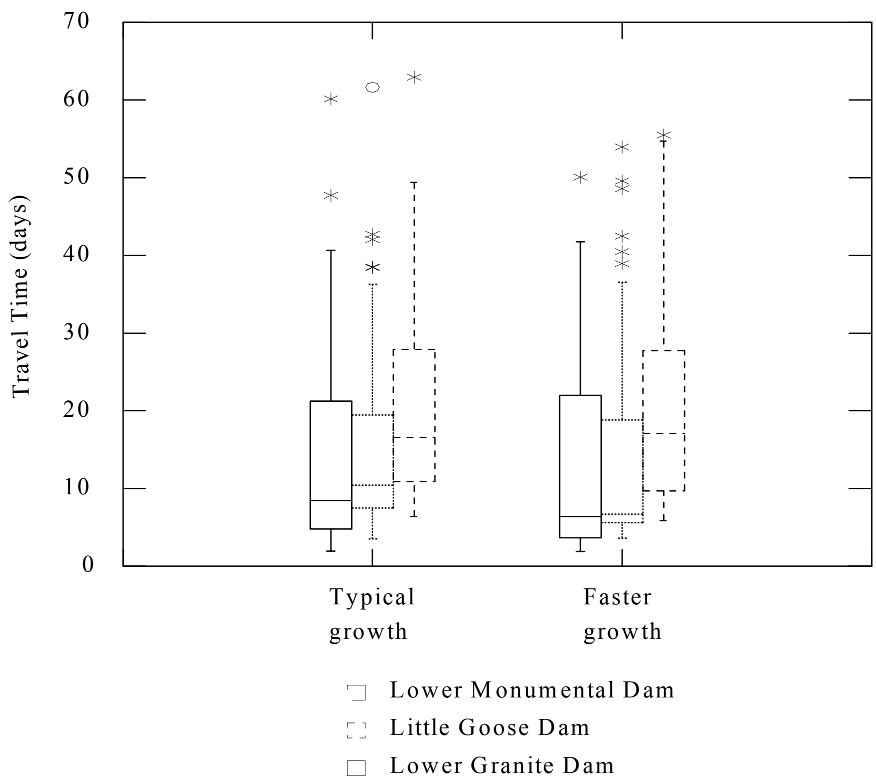

Figure 3. Travel time to Lower Granite, Little Goose, and Lower Monumental dams on the lower Snake River of steelhead reared at two growth rates, Dworshak National Fish Hatchery, 1999.

Similarly, mean survival estimates to Lower Granite Dam for rearing systems in 1999 were 73.5%, 83.4%, and 75.7% for systems I, II, and III. To Lower Monumental Pool, mean survival estimates were 60.4%, 72.3%, and 64.9% for systems I, II, and III. Again, differences were non-significant to either location (*P*=0.22 and *P*=0.19).

Mainstem and North Fork Clearwater rivers.—Our intent was to sample the lower Clearwater River and our four study streams prior to release of steelhead from Dworshak NFH in the spring. However, acquiring our electrofishing boat took longer than anticipated, preventing sampling on the river. Turbid water flows also prevented early sampling of the tributaries.

Thanks to Idaho Department of Fish and Game, we were able to do some sampling in the Clearwater and North Fork Clearwater rivers during the week steelhead were released to offsite locations upstream of the hatchery. We collected 22 steelhead with left-ventral clips, indicating presence of a coded-wire tag, and PIT tagged and released another 84 steelhead (Table 2). All of these coded-wire tagged steelhead were from this year's (1999) releases. It is likely all of the steelhead PIT tagged during this period were also from this year's releases, especially considering their size range (100 to 260 mm fork length). Therefore, these fish will not be analyzed with steelhead captured more than two weeks after release from the hatchery. In fact, 47.6% of these fish were observed emigrating through the federal hydro power system on the Snake and Columbia rivers. Also, nine of the 84 fish were recaptured by National Marine

Fisheries Service's predator project, indicating avian predation.

Additional sampling in the North Clearwater and mainstem Clearwater rivers throughout the summer yielded 320 steelhead. Sixty-three of these were collected for coded-wire tag recovery; another 256 were PIT tagged and released, one other was originally tagged at the hatchery and recorded as a recaptured PIT-tagged steelhead (Table 2).

Very few of these fish were seen to emigrate downstream. Out of 257 steelhead, 3 (1.2%) were later detected at a downstream facility. All three of these fish were sampled early in the season (June 9, 10, and 17). Of the 202 steelhead PIT tagged after July 1 (78.6% of our in-river sample) none were later detected at a downstream facility.

We sampled several steelhead which returned to Dworshak NFH via the adult ladder. Most of these fish returned while the ladder was open for spring chinook and were sampled July 1 through September 7. One recapture occurred in November while the adult ladder was open for steelhead. Samples included 44 steelhead PIT tagged and released, 10 steelhead collected for coded-wire tag retrieval, 3 recaptured PIT-tagged steelhead, and 11 mortalities (Table 2). All recaptured steelhead were originally tagged at Dworshak NFH; one before release, the other 2 were previously tagged at the hatchery rack.

None of these steelhead were observed anywhere downstream of Dworshak NFH subsequent to tagging. Stomachs tended to either be empty or full of spring chinook eggs, and were not included in the analysis.

Table 2. Hatchery steelhead sampled in the Clearwater and North Fork Clearwater rivers, summer 1999.

Sample Site	Collected for coded-wire tags	PIT tagged and released	Recaptures	Unintentional mortality
Clearwater River section:				
Orofino to Big Canyon	44	213	3	4
Big Canyon to Bedrock	6	47	3	4
Bedrock Creek to Myrtle	10	23	-	-
Myrtle to Hog Island	2	1	-	-
Hog Island to Snake	-	3	-	-
North Fork Clearwater	12	54	1	-
Dworshak NFH rack	11	44	3*	11
Totals	85	385	10	19

*all originally tagged at Dworshak NFH; one before release, the other 2 were previously tagged at the hatchery rack.

Tributaries.—Five hatchery steelhead captured in the tributaries were collected for coded-wire tag retrieval; another 31 were PIT tagged and released (Table 3). Eighteen (58%) steelhead PIT tagged in tributaries were detected at a later date emigrating through the Snake River. Sample sizes in tributaries were not large enough to estimate survival emigrating downstream. However, 7 (23 %) received mortality flags further downstream in the system due to avian predation. In addition to hatchery steelhead, 38 wild steelhead were netted and released in the four tributaries.

Table 3. Hatchery steelhead sampled in tributaries of the Clearwater River, summer 1999.

Tributary	Collected for coded-wire tags	PIT tagged and released	Recaptures	Unintentional mortality
Big Canyon Creek	2	1	-	-
Jacks Creek	3	20	-	-
Bedrock Creek	-	1	-	-
Cottonwood Creek	-	10	-	-
Totals	5	32	0	0

Recaptured steelhead.—Recaptured steelhead tended not to travel far. A total of 10 steelhead were recaptured. Two were tagged at the hatchery prior to release. Of these 2, one was recaptured in the mainstem Clearwater River (about 7 km downstream from Dworshak NFH) and the other returned to the hatchery rack. Both of these steelhead were reared in System II at Dworshak NFH. Two more were originally tagged when returning to the hatchery rack, and recaptured in the hatchery rack. Five of the remaining six were recaptured at approximately the same spot 7 to 25 days after their initial capture. One recaptured steelhead had traveled upstream approximately 15 km before its recapture in the river near the hatchery. Growth rates of recaptured steelhead varied from no growth to 0.75 mm per day. This data will be compared with in-river growth when that data becomes available.

Sex and maturity of residual steelhead.—Steelhead which were sacrificed to obtain sex ration data were 65% male, 35% female. Sex ratio was 1:0.7 female:male in 19 steelhead checked immediately after release. None of these fish were precocious. In 80 steelhead caught more than 2 weeks after release and checked, sex ratio was 1:2.3; 46.7% of the males and none of the females were precocious.

Coded-wire tag data.—Coded-wire tags were recovered from 78 of the collected steelhead (Table 4). Seventy-three of these steelhead (94%) were reared at Dworshak NFH and released during 1999. Three recovered steelhead were reared at Clearwater Hatchery and released into Clear Creek, a tributary which joins the Clearwater River 59 kms upstream from Dworshak NFH. There were two coded-wire recoveries from steelhead reared at Dworshak NFH and released during 1998.

Stomach analysis.—During 1999 we sampled 373 stomachs of juvenile hatchery steelhead. Forty-eight, or12.9%, of these steelhead had empty stomachs. Another 41 samples became desiccated or lost and were not included in the analysis.

Steelhead diets were fairly typical (Table 5, Figure 4). Trichoptera was the most common aquatic insect and accounted for 33.2% of the total weight excluding miscellaneous insect parts. Hymenoptera was the most common terrestrial insect and accounted for 22.7% of the total weight excluding miscellaneous insect parts. Crustaceans and molluscs contributed a combined total of 8.9%. Fishes and fish parts made up only 1.2% of the total weight. In the 284 stomach samples analyzed, 3 sculpin, 2 suckers, and 5 sucker larval fishes were found. Also found were fish eggs and 1 unidentified non-salmonid.

Table 4. Coded-wire tag recoveries from release year 1999 during sampling for residual steelhead, Clearwater River and selected tributaries, 1999. Two coded-wire tagged steelhead, which were released during 1998, were recovered during 1999.

Coded-wire tag recoveries, Release Year 1999						
	Release Site					
Rearing System	Dworshak NFH	Clear Creek	South Fork Clearwater	Number released	Total	Percent
Dworshak NFH						
System I	33	0	1	61,294	34	0.06
System II	25	0	0	73,253	25	0.03
System III	7	5	2	70,941	14	0.02
Number Released	130,773	20,041	54,674	205,488		
Total	65	5	3		73	
Percent	0.05	0.02	<0.01			

Table 5. Food item, total number and total weight of stomach contents of juvenile steelhead sampled in the Clearwater River basin from Dworshak National Fish Hatchery and downstream, summer, 1999. Some samples were collected in the tributaries. Empty stomachs were excluded.

Food item	Total number	Total weight (g)	Number of fish containing this item	Percent of fish containing this item
Aquatic insects				
Ephemeroptera	1,305	4.21	167	58.8
Diptera	3,555	7.30	176	62.0
Plecoptera	159	0.98	38	13.4
Odonata	13	3.48	8	2.8
Trichoptera	3,841	23.27	219	77.1
Coleoptera	123	2.07	42	14.8
Lepidoptera	21	0.54	13	4.6
Hemiptera	812	5.36	114	40.1
Terrestrial insects				
Megaloptera	4	0.50	4	1.4
Orthoptera	3	0.33	3	1.1
Hymenoptera	1,801	15.23	138	48.6
Crustaceans				
Isopoda	1	0.03	1	0.4
Amphipoda	4	0.19	3	1.1
Corophium	2	0.01	2	0.7
Cladocera	X	3.69	17	6.0
Decapoda (crayfish, parts)	8	0.31	8	2.8
Mollusca	46	1.97	14	4.9
Pisces				
Nonsalmonid	1	0.12	1	0.4
Larval fishes (suckers)	5	0.04	1	0.4
Castomidae	2	0.01	2	0.7
Cottidae	3	0.69	3	1.1
Fish eggs	X	0.03	2	0.7
Misc. fish flesh	X	0.24	3	1.1
Total	-	119.49	284	-

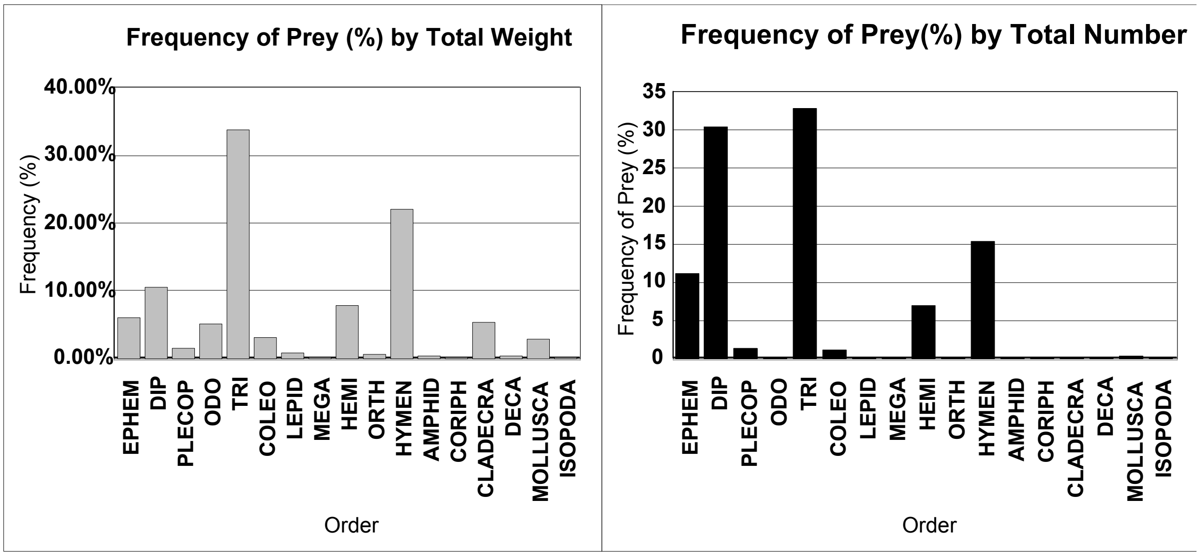

Figure 4. Prey items in stomachs of hatchery steelhead sampled in 1999. Excluding insect parts. Aquatic insects: Ephemeroptera - Ephem, Diptera - Dip, Plecoptera - Plecop, Odonata - Odo, Tricoptera - Tri, Coleoptera - Coleo, Lepidoptera - Lepid, Megaloptera - Mega, Hemiptera - Hemi. Terrestrial insects: Orthoptera - Orth, Hymenoptera - Hymen. Crustaceans: Isopoda- Isopoda, Amphipoda - Amphid, Corophium - Coriph, Cladocera - Cladecra, Decapoda - Deca. Molluscs: Mollusca

Summary and Conclusions

Hatchery rearing practices.—Detection rates and survival estimates for size at release, release sites, and rearing systems will need to be compared over the length of the study for meaningful analysis. Using multiple years will increase the power of our statistics and may reveal differences not apparent in data analyzed one year at a time. Water flow and temperature data will also need to be incorporated into the final analysis. Regardless, we have reported results from this first year of study: Size at release appeared to effect travel time through the lower Snake River, but not emigration success. Release site and rearing system both showed significant differences between treatments with respect to observation rate, but not survival. Steelhead released into Clear Creek were not observed as frequently as those directly released from Dworshak NFH or as those released into the South Fork Clearwater River. When this data was analyzed from a survival-through-the-system perspective, survival estimates, however, were not significantly different. The same holds true for rearing systems at Dworshak NFH. Detection rates were significantly greater for steelhead reared in System II than those reared in systems I and III. Survival estimates, however, were not significantly different.

Characteristics of residual steelhead.—Very few of the steelhead captured in our samples were later seen emigrating toward the ocean. Most recaptured steelhead had not traveled far from their original capture site. Some steelhead even exhibited a ‘hatchery-happy’ behavior: 44 steelhead were captured because they re-entered the hatchery via the adult ladder. Three of these were recaptured a second time via the ladder. The sex ratio of residualized steelhead was overwhelmingly male (1:2.3) and close to half of the males were sexually mature. Whether or not these steelhead will rear in the river and choose to emigrate in a later year has yet to be seen. Data from later years will determine if residual steelhead are postponing emigration for a year or more or are simply not going to exhibit anadromy.

Stomach analysis indicates very little piscivory occurred in residual steelhead in 1999. We found less than 2% of sampled fish were preying on other fish species. Prey fish found were juvenile suckers, sculpins, and one unidentified non-salmonid.

Some hatchery steelhead temporarily rear in Clearwater River tributaries before emigrating oceanward. This behavior could be impacting wild stocks of steelhead by displacing steelhead naturally rearing in the tributary, affecting the wild steelhead's emigration behavior, or directly competing with them for resources. Another potential impact could occur when these fish return as adults. If hatchery steelhead are imprinting on these creeks while temporarily residing in them, returning adults could displace or spawn with the smaller wild A-run steelhead native to the basin. We will continue to sample the tributaries to obtain more data.

Persistence of residual steelhead in the Clearwater River.— We collected two coded-wire-tagged steelhead in 1999 which had been released during 1998, so we know at least some residual steelhead survive through the winter. With the new PIT tag frequencies and larger sample sizes, we will be able to determine if steelhead marked in 2000 do emigrate to the ocean during subsequent years, persist in the Clearwater River, or simply do not survive. Also, coded-wire tag samples and data collection in subsequent years will give more information regarding survival of steelhead which do not emigrate from the Clearwater River.

Effects of changes in PTAGIS operations.—During 1999, we were still using the 400 MHz PIT tags. Because of changes in the PTAGIS system to the 134 MHz tags, we were not able to track emigration of these fish during the following migration season. Sampling during year's 2000, 2001, and 2002 will allow us to determine if residual steelhead are emigrating in years after their release.

Start-up difficulties.—We were unable to obtain as extensive of a data set as we would like during 1999. This was due primarily to delays in obtaining and fine-tuning our electrofishing equipment and boat. Therefore we would like to consider this a pilot year and hope to get an additional year of funding. This would give us three solid years of data to evaluate.

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